Garry Oak Ecosystems Recovery Team

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Pacific Forestry Centre
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ABSTRACTS OF PRESENTATIONS

LANDOWNERS, HERBIVORES AND ATVS: A CASE FOR APPLIED RESEARCH ON THE YELLOW MONTANE VIOLET, SALT SPRING ISLAND

Robin Annschild
Saltspring Island Conservancy

No abstract submitted

CHANGES IN THE LANDSCAPE AND VEGETATION OF SOUTHEASTERN VANCOUVER ISLAND AND SALTSPRING ISLAND SINCE EUROPEAN SETTLEMENT

Anne Bjorkman
Faculty of Graduate Studies (Botany), University of British Columbia, Master of Science Thesis

Land survey data from the mid-1800's represent a unique record of the abundance of tree species, the location of certain habitat types, and the density of forested areas in the landscape. Using equivalent field data from 2007 allows us to identify the changes that have occurred in these areas since European settlement.

QUERCUS GARRYANA RESTORATION IN EASTERN WASHINGTON: AN ANALYSIS OF PLANTING PRACTICES AND MATURE STAND CHARACTERISTICS

Laura Blume

College of Forest Resources, Restoration and Forest Ecology,
University of Washington, Master of Science Thesis

Land clearing for urbanization and agricultural purposes has contributed to the decline of Garry oak ecosystems over the last century. Garry oak restoration plantings have the potential to return degraded areas to healthy oak ecosystems. Studies conducted west of the Cascade Mountains in Washington have investigated the effects of post-planting treatments on survivorship and growth in Garry oak plantings. The climate east of the Cascades is quite different from that on the west side, with colder snowier winters and warmer drier summers. Currently Garry oak restoration efforts on the east side of the Cascades are without guiding research to quantify the benefits of various treatment options in the eastern continental climate.

An abandoned hay field with a remnant oak on lower Swauk Creek in Kittitas County, Washington provides an ideal site for an experimental restoration project to examine the effects of various restoration practices on the east side of the Cascades. A randomized block design will be used to test the effects of tree shelters, brush blankets, irrigation and seedling age at planting on seedling survivorship, diameter increment and height increment for the first 18 months after planting.

Mature stands within 2 km of the planting site and also 45 km farther south on the Tieton River in Yakima County will be surveyed to establish stand structure and species composition targets for restoration projects. Topographical features and variables relating to light, water and nutrient availability will be measured in mature stands in order to better understand factors driving differences among stands. Garry oak growth rates and growth forms will also be compared among stands to facilitate predictions of growth for restoration plantings.

ANNOUNCEMENT AND DISCUSSION OF TWO GARRY OAK PLANT COMMUNITY PUBLICATIONS

Wayne Erickson
BC Ministry of Forests and Range

We now have two companion Garry oak plant community publications available in printed and digital form. Both originate from my M.Sc. thesis work of the mid 1990's. I sort of announced the guide at your last symposium, but it wasn't quite out yet:

Erickson, W.R., and D. Meidinger 2007. *Garry Oak (Quercus garryana) Plant Communities in British Columbia: A Guide to Identification*. B.C. Ministry of Forests Technical Report TR040. Online: http://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr040.htm

We printed 200 copies but they went fast. I extended the publication with three conferences and a poster.

The guide is now complemented by the following publication now available:

Erickson, W.R. 2008. *Results and Data from an Ecological Study of Garry Oak (Quercus garryana) Ecosystems in Southwestern British Columbia*. B.C. Ministry of Forests Technical Report TR043. Online: http://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr043.htm

It was developed contemporaneously but put aside during finalization of the guide. This report has more results, context for the study, methodology and the bibliography used in the study. The data collected to identify and develop the plant communities are found. A similar print run was done so it will be equally available to institutions, libraries and local users.

VICTORIA'S OWL-CLOVER – A NEWLY DESCRIBED SPECIES OF VERNAL POOLS IN THE VICTORIA AREA

Matt Fairbarns
Aruncus Consulting

Castilleja victoriae (Fairbarns and Egger) is a newly-described annual, hemi-parasitic plant restricted to vernal pools in Victoria and the San Juan Islands. Populations have been known since 1893 but had been identified as one of two similar, closely-related species, *C. tenuis* and *C. ambigua*. Indeed, *Castilleja victoriae* shares several characters with each but in a unique combination. Preliminary phylogenetic analyses of chloroplast and nuclear ribosomal DNA sequence data indicate that *C. victoriae* is most closely related to *C. ambigua* and may be recently derived from it. Three extant populations are known, at Trial Island (7,000-8,000 plants), Harling Point (10-30 plants) and an islet in the San Juan Islands chain (100-200 plants). A population at Cattle Point (Victoria) appears to have been recently extirpated and at least two other populations have not been seen for more than 50 years.

Fairbarns M, and J.M. Egger. 2007. *Castilleja victoriae* (Orobanchaceae): a new rare species from southeastern Vancouver Island, British Columbia, Canada, and the adjacent San Juan Islands, Washington, U.S.A. Madroño: Vol. 54, No. 4 pp. 334–342.

TAYLOR'S CHECKERSPOT RECOVERY ACTIONS

Jenny Heron[1] and Nick Page[2]

[1]BC Ministry of Environment, [2]Raincoast Applied Ecology

Taylor's Checkerspot (*Euphydryas editha* spp. *taylori*) is a nationally endangered butterfly with historic records from southern Vancouver Island and adjacent Gulf Islands. The most recent known location is within Helliwell Provincial Park, Hornby Island, but unfortunately the species was extirpated (for unknown reasons) sometime between 1995 and 1998. In 2005, the species was reported from a clearcut on Denman Island and in 2007 surveys were undertaken to clarify the range extent and location of Taylor's Checkerspot on Denman Island.

Surveys were completed by wandering transects through open habitats including recent clearcuts. A total of 1,227 butterfly observations were mapped during the surveys, encompassing 19 species. The most abundant five butterflies were Taylor's Checkerspot (622; 51% of observations), Mylitta Crescent (185; 15%), Western Elfin (93; 8%), Two-banded Checkered Skipper (65; 5%), and Propertius Duskywing (45; 4%).

The majority of butterflies were observed on private land (1,038; 85% of observations) including 605 (97%) of Taylor Checkerspot observations. Only 115 (9%) of observations were from formally protected lands. Butterflies were much more common in modified ecosystems (1,160 observations; 95% in total) rather than natural ecosystems (67; 5%).

Taylor's Checkerspot was found to be widespread and abundant on north central Denman Island. It accounted for over half the butterflies observed during the survey. It was not observed on Hornby Island despite repeated surveys of Helliwell Provincial Park where it occurred historically.

Taylor's Checkerspot was only found in open habitats such as regenerating clearcuts, disturbed meadows, logging roads, and landings. Most of the observations (565; 91%) were made in logged areas; particularly open logged areas (408; 66%) with few or no

standing trees. Observations indicate it prefers moist habitats.

Information on host plant use is incomplete but habitat observations indicate that the traditional larval host plant for Taylor's Checkerspot, lance-leaved plantain (*Plantago lanceolata*), is not the primary host plant for the Denman Island population. Thyme-leave speedwell (*Veronica serpyllifolia*) and American speedwell (*Veronica americana*) are suggested as more important larval host plants and would explain the prevalence of Taylor's Checkerspot in moist, disturbed habitats.

The next step in the recovery actions for Taylor's Checkerspot is to explore the possibility of re-establishing a population on Hornby Island, in the former site at Helliwell Provincial Park. A vegetation assessment was completed to determine host plant patches, threats to the meadow habitat (formerly used by Taylor's Checkerspot) that may still be present and need mitigation prior to re-establishment attempts. Work is ongoing in collaboration with various stakeholders and partners, including those on the recovery implementation group and local conservancy groups.

POPULATIONS OF *ERYNNIS PROPERTIUS* AT SELECTED SITES ON SALTSPRING ISLAND, BRITISH COLUMBIA

Alicia Marshall

Department of Environmental Studies, Trinity Western University, Undergraduate Senior Thesis

Erynnis propertius, commonly known as the Propertius Duskywing, is a rare skipper found on Trinity Western University's Crow's Nest Ecological Research Area located on Saltspring Island located in the Gulf Islands of British Columbia. It was first recorded on the Crow's Nest Ecological Research Area (CNERA) in 2005 (Clements 2006). This species is found in association with Garry Oak ecosystems. Because of its dependence on Garry Oak ecosystems which are in their northernmost range in Canada, *Erynnis propertius* is currently a Blue listed species. This leaves *Erynnis propertius* in a place where it is not quite endangered to the point of being rare, but is still of concern for its future survival if any current conditions or local factors change (GOERT 2003).

Erynnis propertius is a part of the skipper family which displays characteristics of both moths and butterflies. It goes through its larval form as caterpillar and feeds on the leaves of Garry Oaks before it undergoes metamorphosis into a skipper. This cycle generally occurs once a year with the insect wintering in larval form and its flight season occurring in the months of April and May (GOERT 2003).

Methodology for this project included nine transects set up on the CNERA, the Ecological Reserve in Mount Maxwell Provincial Park, and Andreas Vogt Nature Reserve which are all Garry Oak meadow sites located on Saltspring Island, British Columbia. There were three transects at each site measuring thirty metres in length. These transects were monitored twice weekly in search of *Erynnis propertius* (BRC 2006). Observations of where the species were found and behavioural characteristics such as which plants it was observed pollinating were recorded in the field journal in an attempt to better understand its niche.

The resulting data show a brief comparison between the three Saltspring Island sites. Data were collected to obtain background information for potential future study of this species as there is limited information on this species at present as well as improvements for the optimal methodology for monitoring the populations of *Erynnis propertius*.

References:

Biological Records Centre. 2006. "Methods for recording butterfly transects." United Kingdom Butterfly Monitoring Scheme. Accessed: November 7, 2006. <http://www.ukbms.org/methods.htm>.

Clements, Dr. D. 2006. *Written Communication*. Trinity Western University, Biology Dept.

Garry Oak Ecosystems Recovery Team. 2003. Species at Risk in Garry Oak and Associated Ecosystems in British Columbia. Garry Oak Ecosystems Recovery Team, Victoria, British Columbia. Accessed November 7, 2006. <http://www.goert.ca/docs/SARFS_erynprop.pdf>.

LICHEN MONITORING IN QUERCUS GARRYANA ECOSYSTEMS

Steve McCallum
Department of Environmental Studies, Trinity Western University,
Undergraduate Senior Thesis

Southern British Columbia, in the coastal Douglas-fir zone, is the northern limit for Garry Oak trees, which extend down along the coast into California. Garry Oaks (Quercus garryana) are home to a rich diversity of lichens. Though there is still much to learn about the lichens of this endangered ecosystem, at this stage there appears to have only been two published studies and three theses conducted that were focused on them, and none for the last thirteen years. Among Garry oaks, on Salt Spring Island in particular, there has not been exhaustive identification conducted, meaning that there are likely new species to discover, among the crustose, especially. Also no comparisons have been made between lichens on trees in rural savannahs and those on savannahs in urban settings.

This study seeks to utilize the extraordinary ecological indication ability of lichens to assess the Garry Oak ecosystem health of Crows Nest Ecological Research Area (CNERA) on Salt Spring Island relative to a similar ecosystem in Victoria by measuring relative levels of air pollutants. To measure the relative abundance of N and S air pollutants at the CNERA at the and at Christmas Hill Park in Greater Victoria, samples of Parmelia sulcata lichens on Garry Oaks from each site were analyzed for N and S content. In addition, the biodiversity of lichens on Garry Oaks at the CNERA and at Christmas Hill was measured as a point of comparison for future lichen monitoring of the site.

UPDATE ON RARE BRYOPHYTE RESEARCH IN GARRY OAK ECOSYSTEMS

Terry McIntosh
Biospherics Environmental

Research on rare bryophytes is continuing and expanding in coastal British Columbia. Distribution patterns and population details of at least seven species of mosses and five species of liverworts are being studied. One moss species, *Bartramia stricta* (rigid apple moss), has been the focus of a great amount of research over the past few years. This moss is characteristic of open Garry oak related outcrop communities and ranges from Lasqueti Island in the north to Sidney Island in the south. Rare bryophytes are most commonly found in areas that have remained free of human disturbance, but within microsites that are regularly and naturally disturbed. Most of these species grow on soil in or adjacent to spring-wet seepage. Two of the focal species grow on rock and one grows on trees. Many bryologists, especially W. B. Schofield, have collected rare mosses, but interest has increased since COSEWIC and SARA have evolved. Because of this, inventory needs have changed as we are now gathering details on populations, habitats, and threats versus completing inventory and documenting locations. The main recent areas of interest are DND properties (Mary Hill and Notch Hill) and Salt Spring Island. Inventory still needs to be completed on many the Gulf Islands and on some parts of on Vancouver Island, especially near Victoria.

AN INTRODUCTION TO THE POTENTIALLY-RARE INSECTS OF GARRY OAK ECOSYSTEMS

James Miskelly

Insects represent the most diverse group of organisms on the planet, and include many extreme habitat specialists. Few insect groups are assessed by provincial or federal conservation authorities, though there are likely a large number of rare species. This presentation provides an introduction to the diversity of insects that occur in Garry oak ecosystems and are restricted in both range and habitat. Examples include Bradley's robberfly, the island snow scorpionfly, and Steindachner's shieldback katydid. In the absence of information to confirm or deny their rarity, these species can be considered 'potentially rare'.

RESTORATION OF A DEEP-SOILED GARRY OAK (*QUERCUS GARRYANA* DOUGLAS *EX* HOOKER) ECOSYSTEM NEAR DUNCAN, BRITISH COLUMBIA

Dave Polster
Polster Environmental Services

Garry oak ecosystems are becoming increasingly rare due to the pressure of urban expansion and the detrimental impacts of invasive species (GOERT, 2002). Efforts to reverse these trends have led to the development of restoration programs at a number of Garry oak ecosystems on Southern Vancouver Island. The Somenos Garry Oak Protected Area (SGOPA) is a small (8 ha) area that was purchased from a developer by the Province for protection from urban encroachment. The SGOPA has 8 listed rare plant species within its boundaries, three of which are associated with the Garry oak ecosystem while the remaining five listed species occur along the margins of Somenos Marsh. The area is one of only a handful of existing Garry oak ecosystems with deep soils as these were the first areas settled. However, the SGOPA has been subjected to a variety of management regimes, including cattle grazing and urban recreation (dirt bikes, dog walking, etc.) and the ecosystems were significantly degraded. This paper presents the strategy that has been developed for restoration of the SGOPA and the results from work at the site over the past 5 years. Although preliminary in nature, it is hoped that these results will assist others engaged in the restoration of these ecosystems.

ECOLOGY, BIOLOGY, AND CONTROL OF SOME EXOTIC-INVASIVE WEEDS ON FEDERAL LANDS

Raj Prasad[1], J. Benner and S. Bundel

[1]Canadian Forest Service, Natural Resources Canada

Scotch broom (*Cytisus scoparius*), Gorse (*Ulex europaeus*) Daphne (*Daphne laureola*) and English ivy (*Hedera helix*), are four prominent, invasive plants that pose a serious threat to Garry oak and associated ecosystems on federal lands in Victoria, British Columbia. These plants colonize disturbed areas quickly, form dense monospecific stands, remain persistent for a long time and defy any easy eradication program. They suppress and inhibit the growth of native plants and ultimately arrest forest succession. Several federal departments including the Department of Environment, Department of National Defence, Department of Fisheries and Oceans, Department of Indian Affairs and Parks Canada have expressed great concerns regarding their rapid incursion, adverse impacts and the resulting degradation of native habitats. With a grant from the Department of Environment and the Department of National Defence, we conducted research to examine the population dynamics, phenology and control methods of these invasive plants on federal lands near Victoria, B.C. Of the several methods of control tested, including manual cutting, application of a registered herbicide (Release- triclopyr), a fungal bioherbicide (*Chondrostereum purpureum*), and a commercial plastic mulch, it was found that some treatments (mulch and herbicide) provided 100% efficacy on resprouting behaviour of all four invasive species. While one bioherbicide (*Fusarium tumidum*) was very effective on Scotch broom under the greenhouse conditions, it was not applied under field conditions. The other bioherbicide (*Chondrostereum purpureum*) produced a variable response when applied under the field conditions. Manual cutting was found to be the least effective. Also a novel prospective bioagent (*Phomopsis sp*. denovo) was isolated from dying and dead samples of Daphne from the field and results from laboratory, greenhouse and field conditions suggest that it may hold great potential for control of Daphne. Continued and additional research is necessary to determine the appropriate formulations of these bioagents as well as the effectiveness of the

different and integrated control treatments over a period of years. A new technology using superheated water (Aquacide) to kill vegetative shoots of gorse did not offer long term control nor was it found to be cost effective.

MILL HILL REGIONAL PARK RESTORATION AND FIVE YEARS OF RARE PLANT MONITORING

Hans Roemer[1] and Jennifer Psyllakis[2]

[1]Roemer Field Botany Services, [2]BC Ministry of Environment

Garry oak ecosystems make up approximately 33% of Mill Hill Regional Park. The ecological condition of these ecosystems is compromised by invasive species. In 2002, a plan was developed for the park to guide restoration activities for these degraded areas. The main activities included: removal of broom (*Cytisus scoparius*) and laurel-leaf daphne (*Daphne laureola*); establishment of photo-point monitoring plots; establishment of permanent sampling plots to compare plant species composition with and without broom removal (control, n = 9 and treatment, n = 9); and, rare plant monitoring of species that have provincial and / or federal conservation status (e.g., endangered or threatened). Results of monitoring of rare plant populations that were mapped and counted annually since 2002 were presented. Six rare plant species were on record at the outset of the monitoring in 2002. These were distributed in 32 known sites. As a result of the monitoring activity the number of rare species on record had increased to 15 and the number of occurrences (sites) to 195 in 2007. These species and their federal/provincial status are *Balsamorhiza deltoidea* (endangered), *Aster curtus* (threatened), *Sanicula bipinnatifida* (threatened), *Clarkia purpurea ssp. quadrivulnera* (red-listed), *Agrostis pallens* (blue-listed), *Allium amplectens* (blue-listed), *Clarkia amoena* (blue-listed), *Heterocodon rariflorum* (blue-listed), *Lotus unifoliolatus* (blue-listed), *Idahoa scapigera* (red-listed), *Piperia elegans* (blue listed), *Githopsis specularioides* (blue-listed), *Isoetes nuttallii* (blue-listed), *Trifolium depauperatum* (blue-listed), *Thysanocarpus curvipes* (blue-listed). The number of individuals or, where not possible, surrogates for total biomass were tracked for those species where several occurrences were known for three or more years. Year to year fluctuations in numbers were most pronounced for the eight annuals among these species. The perennial species either held their own or increased slightly. The only consistent decrease from year to year in the park occurred in *Clarkia amoena* (farewell-to-spring). A drought year (2006) followed by a “wet” year (2007) was reflected in the

population size of seven out of the 15 species. In summary, a high search effort has resulted in a considerable increase of rare species, their sites and their population numbers. Variations from year to year occurred in the population size for most species and are highly weather-dependent. No significant short-term effect of broom removal on rare plant populations could be recognized.

VEGETATION ECOLOGY OF ROCK OUTCROP ECOSYSTEMS OF THE GULF ISLANDS IN THE COASTAL DOUGLAS-FIR ZONE, BRITISH COLUMBIA

Kella Sadler

Sadler, Reid & Associates Environmental Consulting

Rock outcrop ecosystems of the Gulf Islands in the Coastal Douglas-fir (CDF) biogeoclimatic zone of British Columbia were investigated at multiple scales with the following objectives: (1) to refine distribution information for constituent species, (2) to investigate landscape (i.e. site-level) features that influence the patterning of native and introduced plant species of rock outcrop habitats, including (a) geographic position (latitude), (b) geology (rock type), and (c) grazing intensity, (3) to integrate vegetation patterns observed at each sampling scale (site, plot, microplot) to derive a classification scheme for rock outcrop vegetation, and (4) to interpret rock outcrop ecosystem dynamics and address conservation and management implications.

TACTICAL LESSONS IN RECLAIMING OCCUPIED TERRITORY: SIX YEARS OF RESTORATION AT FORT RODD HILL NATIONAL HISTORIC SITE, VICTORIA

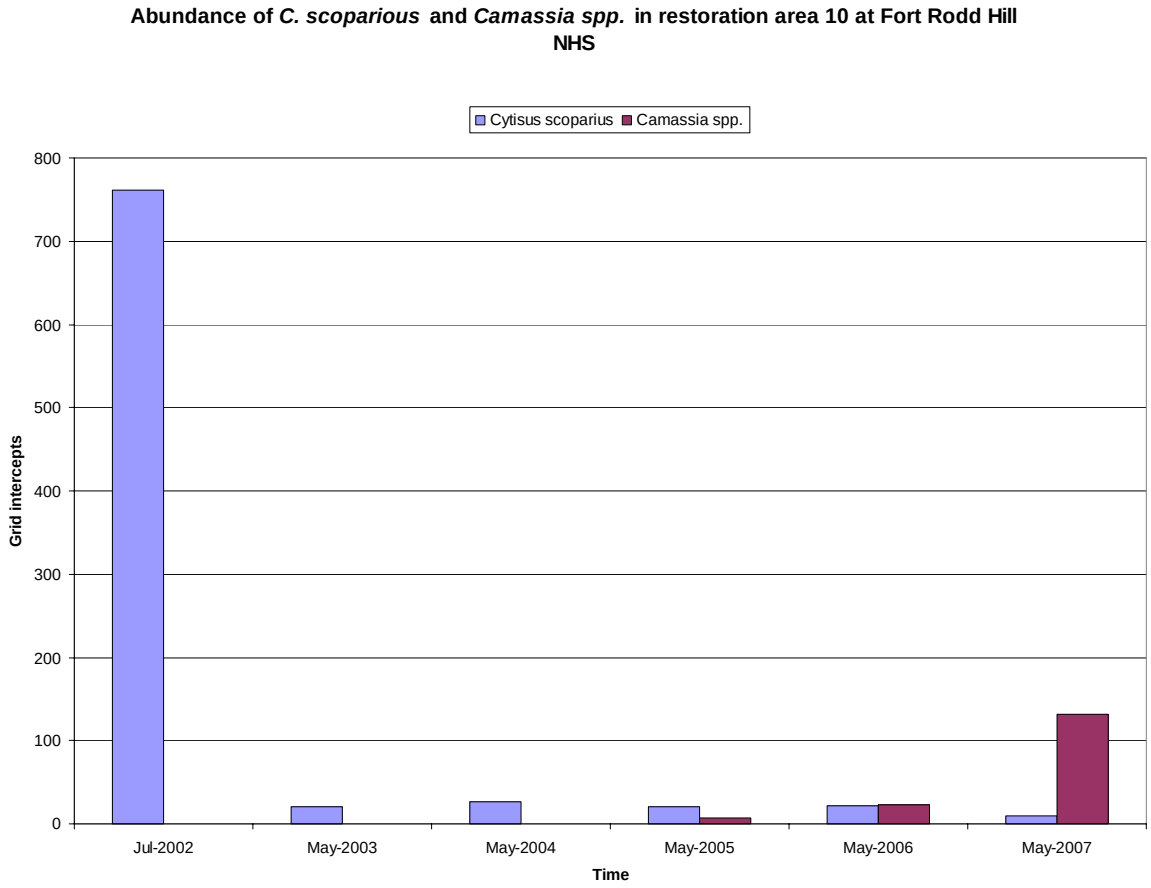
Conan Webb
Parks Canada

Fifty-four hectares of land are protected within Fort Rodd Hill and Fisgard Lighthouse National Historic Sites. Fort Rodd Hill National Historic Site (FRHNHS) contains significant examples of remnant Garry oak and associated ecosystems. Ecosystem restoration has been ongoing at FRHNHS for the last six years.

The main restoration activities at FRHNHS include invasive species research and removal, and native species propagation and planting. Invasive species control has been undertaken to varying extents across the 54 hectares of land managed by Parks Canada Agency. Research on spurge-laurel (*Daphne laureola*) has been successful at discovering effective control techniques. Adult plants must be cut below ground (at or below the root collar) as they do not sprout from roots, but will sprout prolifically from any remnant aerial stem. Cutting is easily done using bypass loppers.

Extensive spurge-laurel seedling germination is often seen after the removal of well-established adult plants. This germination is observed to decline drastically after two years. Furthermore, young seedlings do not seem to have the same ability as adults to sprout from aerial shoots. Cutting with a weed-eater appears to be an effective control method for seedlings, but methods for minimizing operator exposure to toxic aerosols from spurge-laurel plants need to be employed, and disturbance of the duff layer must be considered carefully.

So far, the best method for removing large patches of seedlings appears to be shearing the seedlings off as close to ground as possible using hedge shears, stand-up grass shears, or a similar tool. Small patches of seedlings can easily be hand-pulled. It should be noted that spurge-laurel individuals seem to mature and produce their first



flowers at five years of age. This is important since seedling control treatments should be initiated prior to reproductive age. A potential spurge-laurel management strategy is as follows:

1. Cut (not pull), and remove mature plants,
2. Wait two years for bulk of seedlings to germinate,
3. Kill seedlings by shearing close to ground in their third year,
4. Pull out future seedlings before seed set (seed set is ~5 years after germination)

Figure 1. Relative abundance of C. scoparious and Camassia spp. in restoration area 10 at Fort Rodd Hill National Historic Site. Based on a grid intercept analysis of annual repeat photography photos. NB: due to the difficulty of distinguishing graminoids and *Camassia spp.* leaves at a distance in photos, only camas blooms were counted in the analysis while entire *C. scoparious* shrubs were included.

Conversion of a small orchard grass (*Dactylis glomerata*) monoculture (~0.01 hectares) to native grass appears to be possible

with a reasonable effort. Orchard grass can be removed by cutting the root crown (intercalary meristem) out of the soil using a hooked knife or other suitable tool. This method is likely effective for other tufted grasses. Local native grass seed (*Elymus glaucus, Bromus sitchensis, Bromus vulgaris*) can be collected in the summer and grown as plugs within a short time (11 weeks or less in 310 styrobock) for planting in the fall (density of ~25 plugs / m^2). Follow-up work will be needed to remove surviving orchard grass from the area before it sets seed.

While removal of invasive species has been successful and, on its own, removal effort has relieved some of the pressure on the ecosystems at FRNHNS, it was not until excessive herbivory by deer was dealt with that recovery of native vegetation progressed noticeably. Hyper-abundant deer have a significant impact on the flora or FRHNHS: nearby sites have deer populations estimated at almost 50 deer/km^2. Installation of a deer fence around a rocky outcrop enclosed ~0.6 hectares and resulted in the dramatic increase in native wildflower blooms, including camas (*Camassia* spp.), spring gold (*Lomatium utriculatum*), and other species.

No *Camassia* spp. blooms were detected in monitoring photos for the two years prior to fence installation in area 10 (Figure 1). After fence installation, while the number of blooming *Camassia spp*. increased in area 10, they remained scant in most in other sites at FRHNHS. Inspection of unfenced sites reveals an abundance of *Camassia spp.* with leaves and flower stalks cropped to within a few centimetres of the ground.

It must be noted that ecosystem restoration is a long-term prospect. Annual monitoring and maintenance has been occurring at some FRHNHS sites for six years and will be required for the foreseeable future. However, encouraging results have been obtained in the few years that this program has been underway.

THE GARRY OAK MEADOW GARDEN AT UBC BOTANICAL GARDEN: ITS PURPOSE, PLANTS AND DEVELOPMENT

Tom Wheeler
University of British Columbia Botanical Garden

Our Botanical Garden exists to educate or to assist in the education of the University and greater community. The purpose of the Garry Oak Meadow Garden (GOMG) is to provide enjoyment, learning and research that can focus on issues as diverse as biodiversity and conservation, climate change, fossil fuel and water conservation and relevant amenity garden environments. Prior to the assembly of GOM plant species and the creation of the GOMG, I reviewed the GOE scientific literature. I learnt from informants and researchers. I used their information and articles to compile a subject-keyed Garry Oak Meadow Resource Manual. In our GOM, we strived for authenticity; the plants were grown from BC wild collected seed. During the presentation, images of various GOE plants and their scientific names were displayed. Thanks to UBC accessibility funding, contractors lowered the path grade and changed the garden contours. Thereby, we were able to raise the exhibit diversity and quality via an enlarged GO meadow area. I outlined the site characteristics; topographical history, prior garden landscapes, native soils and substrates to bedrock and equipment and materials used. During May and November 2007, we planted the site with woody plants, grasses, perennial herbs, bulbs and annuals (in sequence of planting). I used what I had learnt from scientific articles to write a GOMG Horticulturist's Orientation Manual for Botanical Garden installation and maintenance staff. Between our Garden and the GOE, there are many differences and a few similarities in macro and micro phenomena. Therefore, our GOMG is experimental and may require compromise. So that our tour guides (Friends of the Garden) can successfully interpret the Garden, I wrote a GOMG Tour Guide Manual based on my research. To provide an additional historic and human link, I extracted the GOE-specific ethnobotanical research from Nancy Turner's writings. To reiterate, active and passive education is key to our mission as an international botanical garden. We have taken the risk and built a scientifically documented,

experimental garden. We believe that learners, teachers and researchers, visitors and donors will support us in our endeavour. If we are successful, the GOMG will grow in diversity and size. In conclusion, I thanked the many people who directly assisted and encouraged me, including the people at GOERT.

CONTRIBUTED PAPERS

RISK TO OREGON WHITE OAK HABITATS FROM ORTHODOXY IN THE REGULATION OF SPECIES

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A review of works by others suggests society inadvertently risks exacerbating the loss of Oregon white oak (*Quercus garryana*, or Garry oak) habitats by disregarding risk to species from regulatory land-use restrictions or exactions based on the presence of species on private land. Statutes authorizing such "regulation of species" include the US Endangered Species Act of 1973 (ESA), Canada's Species at Risk Act, and Oregon's Goal 5. The US Fish and Wildlife Service (FWS) has expressed concern for almost a decade that such regulation can inadvertently harm regulated species on private land, by discouraging good stewardship. Supporting this concern, recent statistical analysis suggests that without substantial public funding, such regulation tends to worsen the fate of regulated species. Yet a review of governmental, scholarly, and popular works shows that conservation policies and discourse routinely disregard this risk. Some evidence suggests this disregard persists in part to defend the power of individuals to use the presence of species to secure scenery or other open-space amenities on the property of others. These findings imply that with constraints on public funding, the fate of Oregon white oak habitats might depend on (1) clarifying whether the primary goal of regulating species is to ensure their survival or to limit harm to species from land use, and (2) more fully considering an alternate strategy of openly refraining from regulating Oregon white oak-associated species on private land. For example, with sufficient discretion, regulators might implement such a strategy through a "truce" list, to signal that maintaining oak-associated species is no riskier to individuals than growing exotic ornamental vegetation, and to redirect any associated funding to further the conservation of these species through truly voluntary means. In the US, FWS might have an opportunity to expand its discretion through ESA section 10, if FWS

determines these species stand little chance of surviving in the wild, because their survival depends on active management by humans.

WHAT LIMITS THE ABUNDANCE OF A RARE PLANT, *VIOLA PRAEMORSA*?

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Rare plants in remnant areas of degraded ecosystems often have limited and clustered distributions but the mechanisms explaining this pattern are not always obvious. This clustering may be due two different processes: habitat specializations, where species occurrences depend on the availability of specific habitat conditions, or dispersal limitation, caused by seeds remaining near the parent plant. These possibilities are equally feasible in remnants of the Garry Oak Ecosystem (GOE). Furthermore, these processes have different implications for the causes, and potential cures, of plant rarity. We test these hypotheses for *Viola praemorsa*, the prairie violet, which has declined by 75% in the last 10 years (Fairbarns 2006)[1]. We used a variety of mapping and experimental approaches to determine how environmental conditions and spatial factors influence the following characteristics: distribution, performance (reproduction and growth), establishment, and dispersal. We found evidence for both hypotheses, although the outcome varied by spatial scale.

At the site level (Nature Conservancy of Canada's Cowichan Bay Reserve, approximately 10.3ha) the violet had higher abundance in partially canopied areas that were low in grass and shrub cover. Furthermore experimental seed additions revealed that establishment was possible over a much wider area than what is currently occupied, and suitable habitats exist that are unoccupied by *V. praemorsa*. Seedling surveys revealed that natural recruitment is occurring, with densities >100/m^2 in some areas, but it mainly occurs within 30cm of the nearest adult. This dispersal limitation could be explained by grass cover preventing ballistic seed dispersal and because ants, which were thought to move the seeds long-distances, rarely carried the seeds more than a few centimetres.

[1] Fairbarns, M. 2006. Update COSEWIC status report on yellow montane violet, *Viola praemorsa*: Prepared for the Committee on the Status of Endangered Wildlife in Canada. British Columbia, Canada.

At a finer spatial scale (within the patches where the violet occurs, <30m), we found that environmental factors, not dispersal inefficiencies, explained plant abundance. Although the violet occurs throughout these patches, abundance and reproductive performance were higher in slightly drier, shadier and nutrient-rich microsites. As is typical of woodland understories, this microsite variability was non-linear and varied widely over short distances (<2m). Because of this unpredictability at the fine-scale, plants establish everywhere within the patch but differ widely in abundance and performance based on microsite habitat.

Our study reveals that *V. praemorsa* has certain identifiable broad-scale environmental requirements (i.e. its 'critical habitat'), but its patchiness is also explained by dispersal limitations. The violet could occur over a wider area in the Cowichan Reserve, and presumably at other GOE sites. Reintroductions in these areas could target partially shaded oak woodland that is not overwhelmed by grass or snowberry cover. Restoration efforts *within* these patches is probably unnecessary, because at a fine-scale important factors (such as soil moisture, nutrients and light) are difficult to measure and change temporally.

RECENT THESES

THE EFFECTS OF HERBIVORY, COMPETITION, AND DISTURBANCE ON ISLAND MEADOWS

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It is an unresolved paradox that non-native species are successful in novel environments whereas native species, presumably adapted to that environment, decline. This knowledge gap has persisted because third party processes in invasion ecology have been overlooked. Ungulate densities are increasing due to the eradication of predators and landscape change and I asked how herbivory and invasion might interact to cause declines of native species. In Garry oak meadows, Canada's most endangered ecosystem, native forbs have declined relative to non-native grasses and I tested the facilitatory role of herbivory in that degradation. My investigations, novel to the field, were conducted on islands spanning the Canada-US border. Islands served as natural experimental units in a mensurative study of abundance patterns in seven plant groups and 15 focal species along gradients of herbivory, biogeography, soil depth, and human activities. Increasing ungulate densities were related to declines in abundances of native forbs, and increasing abundances of non-native annual grasses. These regional patterns were upheld by two plot-based, 2x2 factorial experiments that contrasted the fitness of native species under manipulations of herbivory and competition for light. Specifically, I showed that ungulates limited the establishment, growth, survival and reproduction of seedlings and transplanted native forbs and shrubs and that competition from non-native species had little effect. I also calculated forage selectivity indices and tested the efficacy of fencing and cutting to reduce competition, for the restoration of native community biomass. Non-native annual grasses were rarely browsed and increased with increasing ungulate density. Non-native perennial grasses declined with herbivory, however, their regional abundances were unaffected by ungulate density despite being preferentially foraged. That non-native annual and perennial

grasses differed in their responses to herbivory has consequences for restoration and illustrates the challenge of developing a comprehensive theory of invasion. Reducing ungulates, necessary for the recovery of native forbs, also benefits non-native perennial grasses and therefore their removal speeds recovery of Garry oak meadows. Despite advances in invasion ecology, scientists and managers are disconnected and research is rarely implemented. I conclude by proposing seven solutions to facilitate the integration of science into management.

DETERMINANTS OF NATIVE AND EXOTIC PLANT SPECIES DIVERSITY AND COMPOSITION IN REMNANT OAK SAVANNAS ON SOUTHEASTERN VANCOUVER ISLAND

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Master of Science Thesis

Many regional and local factors can influence the distribution of native and exotic species in ecological communities. I examined the regional- and local-scale determinants of native and exotic vascular plant species richness and composition in a highly fragmented oak savanna ecosystem on southeastern Vancouver Island. In sharp contrast to most reported results, I found a negative relationship between native and exotic richness at the regional scale, and no relationship at the local scale. Two extrinsic factors, surrounding road density and climate, best explained the regional-scale relationship by each affecting natives and exotics in opposite ways. Road density and climate were also the dominant predictors of native and exotic composition at the regional scale. Patterns in the patch occupancy of individual species confirmed the importance of these factors but I found that low surrounding road densities and cool, wet conditions predicted the presence of many natives and the absence of many exotics. Environmental factors explained variation in richness and composition at the local scale, but these factors were different for natives and exotics. My results suggest that natives and exotics respond to roads and climate in fundamentally different ways. Roads increase both exotic propagule pressure and disturbance, which may facilitate exotic invasion. In contrast, disturbance from roads may increase the likelihood of local extinction for particular natives. Differing climatic preferences within the native and exotic species pools may also partially explain the observed patterns. There was no evidence that native diversity directly affects exotic diversity (or vice versa). Surprisingly, I found that connectivity was not an important predictor of richness or composition despite the high degree of habitat fragmentation in this ecosystem.

Thesis available at: http://hdl.handle.net/2429/243

GARRY OAK SAVANNAH STAND HISTORY AND CHANGE IN SOUTHERN COASTAL BRITISH COLUMBIA

Shyanne Smith

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Master of Science Thesis

In this thesis I investigate the history of Garry oak (Quercus garryana) savannah patches in coastal British Columbia and the changes to these ecosystems over recent centuries. Remnant Garry oak patches have been altered by agriculture, development, increased herbivory, exotic plants, and fire suppression. Identifying the historical stand structure and ecosystem processes is therefore critical for effective site management and restoration. In this study, tree-ring analysis was used to reconstruct the stand and disturbance history at eight Garry oak communities within and adjacent to the Gulf Islands National Park Reserve. Varying levels of disturbance and tree establishment were found to have occurred at the time of European settlement. After the initial colonization by Garry oak, Douglas-fir (*Pseudotsuga menziesii*) recruitment increased and has been ongoing. Results from the smaller islands suggest that local environmental conditions, weather events, and competitive interactions are important controls of ecosystem dynamics on these sites.

ADDITIONAL PUBLICATIONS OF INTEREST

MacDougall, A. S., B. R. Beckwith, and C. Y. Maslovat. 2004. Defining conservation strategies with historical perspectives: A case study from a degraded oak grassland ecosystem. Conservation Biology 18(2):455-465.

MacDougall, A. S., J. Boucher, R. Turkington, and G. E. Bradfield. 2006. Patterns of plant invasion along an environmental stress gradient. Journal of Vegetation Science 17(1):47-56.

MacDougall, A. S., and R. Turkington. 2004. Relative importance of suppression-based and tolerance-based competition in an invaded oak savanna. Journal of Ecology 92(3):422-434.

MacDougall, A. S., and R. Turkington. 2005. Are invasive species the drivers or passengers of change in degraded ecosystems? Ecology 86(1):42-55.

MacDougall, A. S., and R. Turkington. 2006. Dispersal, competition, and shifting patterns of diversity in a degraded oak savanna. Ecology 87(7):1831-1843.